

FORM PTO-1390	<b>U.S. DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE</b> <b>TRANSMITTAL LETTER TO THE UNITED STATES</b> <b>DESIGNATED/ELECTED OFFICE (DO/EO/US)</b> <b>CONCERNING A FILING UNDER 35 U.S.C. 371</b>	ATTORNEY'S DOCKET NUMBER: MPM/ph/13504-USA  U.S. APPLICATION NO. (If known, see 37 CFR 2.51) <b>09/914720</b>
INTERNATIONAL APPLICATION NO.: PCT/IB00/00216	INTERNATIONAL FILING DATE: 28 FEBRUARY 2000	PRIORITY DATE CLAIMED: 2 MARCH 1999 (02.03.99)
TITLE OF INVENTION: TUBING FOR THE EXTRACORPORAL OXYGENATION OF THE BLOOD AND USE OF THIS TUBING		
APPLICANT(S) FOR DO/EO/US: Olivier FAVRE		

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1. ☒ This is a **FIRST** submission of items concerning a filing under 35 U.S.C. 371.
2. ☐ This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 U.S.C. 371.
3. ☒ This express request to begin national examination procedures (35 U.S.C. 371(f)) at any time rather than delay examination until the expiration of the applicable time limit set in 35 U.S.C. 371(b) and PCT Articles 22 and 39(1).
4. ☒ A proper Demand for International Preliminary Examination was made by the 19th month from the earliest claimed priority date.
5. ☒ A copy of the International Application as filed (35 U.S.C. 371(c)(2))
  - a. ☒ is transmitted herewith (required only if not transmitted by the International Bureau --*in French language*).
  - b. ☐ has been transmitted by the International Bureau. (see attached copy of PCT/IB/308)
  - c. ☐ is not required, as the application was filed in the United States Receiving Office (RO/US).
- ☒ A translation of the International Application into English (35 U.S.C. 371(c)(2)).
- ☐ Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371(c)(3)).
  - a. ☐ are transmitted herewith (required only if not transmitted by the International Bureau).
  - b. ☐ have been transmitted by the International Bureau.
  - c. ☐ have not been made; however, the time limit for making such amendments has NOT expired.
  - d. ☐ have not been made and will not be made.
- ☐ A translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)).
- ☒ An oath or declaration of the inventor(s) (35 U.S.C. 371(c)(4)).
10. ☐ A translation of the annexes of the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371(c)(5)).

Item 11. to 16. below concern document(s) or information included:

11. ☐ An Information Disclosure Statement under 37 CFR 1.97 and 1.98.
12. ☒ An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.
13. ☒ A **FIRST** preliminary amendment.
- ☐ A **SECOND** or **SUBSEQUENT** preliminary amendment.
14. ☐ A substitute specification.
15. ☐ A change of power of attorney and/or address letter.
16. ☒ Other items or information: INTERNATIONAL PRELIMINARY EXAMINATION REPORT (PCT/IPEA/409), INTERNATIONAL SEARCH REPORT (PCT/ISA/210), APPLICATION DATA SHEET, ABSTRACT

U.S. APPLICATION NO. <b>09/914720</b> <small>(known see 37 CFR 1.51)</small>		INTERNATIONAL APPLICATION NO. PCT/IB00/00216		ATTORNEY'S DOCKET NO MPM/ph/13504-USA																																																					
17. <input checked="" type="checkbox"/> The following fees are submitted:  <b>BASIC NATIONAL FEE (37 CFR 1.492(a)(1)-(5)):</b> Neither international preliminary examination fee (37 CFR 1.482) nor international search fee (37 CFR 1.445(a)(2)) paid to USPTO and International Search Report not prepared by the EPO or JPO ..... \$ 1,000.00  International preliminary examination fee (37 CFR 1.482) not paid to USPTO but International Search Report prepared by the EPO or JPO ..... \$ 860.00  International preliminary examination fee (37 CFR 1.482) not paid to USPTO but international search fee (37 CFR 1.445(a)(2)) paid to USPTO ..... \$ 710.00  International preliminary examination fee (37 CFR 1.482) paid to USPTO but all claims did not satisfy provisions of PCT Article 33(1)-(4) ..... \$ 690.00  International preliminary examination fee (37 CFR 1.482) paid to USPTO and all claims satisfied provisions of PCT Article 33(1)-(4) ..... \$ 100.00  <div style="text-align: right;"><b>ENTER APPROPRIATE BASIC FEE AMOUNT =</b></div>				CALCULATIONS PTO USE ONLY																																																					
				<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td colspan="2" style="text-align: right;">Surcharge of \$130.00 for furnishing the oath or declaration later than months from the earliest claimed priority date (37 CFR 1.492(e)).</td> <td style="text-align: right;">\$</td> <td></td> </tr> <tr> <td style="text-align: center;">CLAIMS</td> <td style="text-align: center;">NUMBER FILED</td> <td style="text-align: center;">NUMBER EXTRA</td> <td style="text-align: center;">RATE</td> </tr> <tr> <td>Total claims</td> <td style="text-align: center;">10 - 20 =</td> <td style="text-align: center;">0</td> <td style="text-align: center;">X \$18.00</td> </tr> <tr> <td>Independent claims</td> <td style="text-align: center;">1 - 3 =</td> <td style="text-align: center;">0</td> <td style="text-align: center;">X \$80.00</td> </tr> <tr> <td colspan="3">MULTIPLE DEPENDENT CLAIMS(S) (if applicable)</td> <td style="text-align: center;">+ \$270.00</td> </tr> <tr> <td colspan="2" style="text-align: right;"><b>TOTAL OF ABOVE CALCULATIONS =</b></td> <td style="text-align: right;">\$</td> <td style="text-align: right;">860.00</td> </tr> <tr> <td colspan="2">Reduction of 1/2 for filing by small entity, if applicable. Applicant claims Small Entity Status under 37 CFR 1.27.</td> <td style="text-align: right;">\$</td> <td style="text-align: right;">430.00</td> </tr> <tr> <td colspan="2" style="text-align: right;"><b>SUBTOTAL =</b></td> <td style="text-align: right;">\$</td> <td style="text-align: right;">430.00</td> </tr> <tr> <td colspan="2">Processing fee of \$130 for furnishing the English translation later than months from the earliest claimed priority date (37 CFR 1.49(f)).</td> <td style="text-align: right;">\$</td> <td></td> </tr> <tr> <td colspan="2" style="text-align: right;"><b>TOTAL NATIONAL FEE =</b></td> <td style="text-align: right;">\$</td> <td style="text-align: right;">430.00</td> </tr> <tr> <td colspan="2">Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31). \$40.00 per property</td> <td style="text-align: right;">\$</td> <td style="text-align: right;">40.00</td> </tr> <tr> <td colspan="2" style="text-align: right;"><b>TOTAL FEES ENCLOSED =</b></td> <td style="text-align: right;">\$</td> <td style="text-align: right;">470.00</td> </tr> <tr> <td colspan="2"></td> <td style="text-align: right;">Amount to be refunded:</td> <td></td> </tr> <tr> <td colspan="2"></td> <td style="text-align: right;">charged:</td> <td></td> </tr> </table>		Surcharge of \$130.00 for furnishing the oath or declaration later than months from the earliest claimed priority date (37 CFR 1.492(e)).		\$		CLAIMS	NUMBER FILED	NUMBER EXTRA	RATE	Total claims	10 - 20 =	0	X \$18.00	Independent claims	1 - 3 =	0	X \$80.00	MULTIPLE DEPENDENT CLAIMS(S) (if applicable)			+ \$270.00	<b>TOTAL OF ABOVE CALCULATIONS =</b>		\$	860.00	Reduction of 1/2 for filing by small entity, if applicable. Applicant claims Small Entity Status under 37 CFR 1.27.		\$	430.00	<b>SUBTOTAL =</b>		\$	430.00	Processing fee of \$130 for furnishing the English translation later than months from the earliest claimed priority date (37 CFR 1.49(f)).		\$		<b>TOTAL NATIONAL FEE =</b>		\$	430.00	Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31). \$40.00 per property		\$	40.00	<b>TOTAL FEES ENCLOSED =</b>		\$	470.00			Amount to be refunded:	
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SEND ALL CORRESPONDENCE TO.  YOUNG & THOMPSON 745 South 23rd Street 2nd Floor Arlington, VA 22202 (703) 521-2297 facsimile (703) 685-0573 <b>Customer Number: 000466</b>																																																									
September 4, 2001			By <u><i>Benoit Castel</i></u> Benoit Castel Attorney for Applicant Registration No. 35,041																																																						

PATENTS

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re application of

Olivier FAVRE

Serial No. (unknown)

Filed herewith

TUBING FOR THE EXTRACORPORAL PURIFICATION  
OF THE BLOOD AND USE OF THIS TUBING

PRELIMINARY AMENDMENT

Commissioner for Patents

Washington, D.C. 20231

Sir:

Prior to the first Official Action and calculation  
of the filing fee, please amend the specification as follows:

IN THE SPECIFICATION:

Please replace the paragraph beginning at page 9,  
line 14, with the following rewritten paragraph:

--Preferably, the recovery chamber 15 and one or  
several substitution solution sources 16, 16' are constituted  
by flexible pockets disposed in one or several containers 12,  
preferably rigid. The information as to this container 12 can  
preferably be recorded and displayed by a member 23. The  
container used and the different possible embodiments corre-  
spond preferably to the container described in FR 2782916, to  
which reference can be had for more details.--

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Prior to the first Official Action and calculation of the filing fee, please amend claims 1-7 as follows:

IN THE CLAIMS:

--1.(Amended) Tubing for the extracorporeal purification of the blood of a human being or a warm-blooded animal, comprising an open loop extracorporeal circulation conduit having two portions, one for extraction of the blood to be purified (1), the other for return of the purified blood (2), adapted to be connected to purification means (6), at least one conduit (29, 30, 31) to connect at least one of said portions (1, 2) to a source (16, 16') of a substitution solution, a bubble trap (7) located along said loop, an evacuation product (28) for product rejected into a recovery chamber (15) by said purification means, provided with a segment adapted to serve as a pump body adapted to be connected with a peristaltic pump and connection means (11) removably to connect to each other the respective ends (45, 46) of said open loop extracorporeal circulation tubing (1, 2) to form a closed loop, said evacuation conduit (28) for rejecting product comprising, downstream of said segment adapted to serve as a pump body, a blood detector (14), characterized in that a connection conduit (8) extends between the downstream end of said segment adapted to serve as a pump body and said bubble trap (7).

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2.(Amended) Tubing according to claim 1, characterized in that it moreover comprises a buffer reservoir (50) in the section of the circulation loop adapted to be located downstream of said purification means.

3.(Amended) Tubing according to claim 1, characterized in that said connection conduit (8) comprises means (47) to control the flow rate through it.

4.(Amended) Tubing according to claim 1, characterized in that each of said portions (1, 2) of said circulation element is connected to said source (16, 16') of substitution solution.

5.(Amended) Tubing according to claim 1, characterized in that said conduit (29) for connecting at least one of said portions of said circulation conduit (1, 2) to said source of substitution solution, comprises a junction and switching means (32) alternatively to connect said portion to at least two chambers (16, 16') for said solution.

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6.(Amended) The use of tubing according to claim 1, said circulation conduit (1, 2) forming a closed loop, characterized in that the liquid is caused to circulate in said closed circulation loop (1, 2) to evacuate air which it contains, through said connection conduit (8).

7.(Amended) The use of the tubing according to claim 6 characterized in that the extraction pump for blood is actuated when the blood return pump (17) is stopped and until the pressure measured by the detector (42) reaches or exceeds a predetermined threshold value.--

#### R E M A R K S

The above changes in the specification and claims merely place this national phase application in the same condition as it was during Chapter II of the international phase, with the multiple dependencies being removed. Only claims 1-10 remain pending in this application. Attached hereto is a marked-up

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version of the changes made to the specification and claims by  
the current amendment. The attached page is captioned  
"Version with markings to show changes made".

Respectfully submitted,

By Benoit Castel YOUNG & THOMPSON  
Benoit Castel  
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745 South 23<sup>rd</sup> Street  
Arlington, VA 22202  
703/521-2297

September 4, 2001

"VERSION WITH MARKINGS TO SHOW CHANGES MADE"

In the specification:

Paragraph beginning at line 14 of page 9 has been amended as follows:

Preferably, the recovery chamber 15 and one or several substitution solution sources 16, 16' are constituted by flexible pockets disposed in one or several containers 12, preferably rigid. The information as to this container 12 can preferably be recorded and displayed by a member 23. The container used and the different possible embodiments correspond preferably to the container described in FR 9812705, 2782916, to which reference can be had for more details.

In the claims:

Claims 1-7 has been amended as follows:

1. (Amended) Tubing for the extracorporeal purification of the blood of a human being or a warm-blooded animal, comprising an open loop extracorporeal circulation conduit having two portions, one for extraction of the blood to be purified (1), the other for return of the purified blood (2), adapted to be connected to purification means (6), at least one conduit (29, 30, 31) to connect at least one of said portions (1, 2) to a source (16, 16') of a substitution solution, a bubble trap (7) located along said loop, an evacuation product (28) for product rejected into a recovery chamber (15) by said purifi-

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cation means, provided with a segment adapted to serve as a pump body adapted to be connected with a peristaltic pump and connection means (11) removably to connect to each other the respective ends (45, 46) of said open loop extracorporeal circulation tubing (1, 2) to form a closed loop, ~~characterized in that~~ said evacuation conduit (28) for rejecting product ~~comprises;~~ comprising, downstream of said segment adapted to serve as a pump body, a blood detector (14), characterized in that a connection conduit (8) ~~extending~~ extends between the downstream end of said segment adapted to serve as a pump body and said bubble trap (7).

2. (Amended) Tubing according to claim 1, characterized in that it moreover comprises a buffer reservoir (50) in the section of the circulation loop ~~between the pumps 5 and 17~~ adapted to be located downstream of said purification means.

3. (Amended) Tubing according to ~~one of the preceding claims,~~ claim 1, characterized in that said connection conduit (8) comprises means (47) to control the flow rate through it.

4. (Amended) Tubing according to ~~one of the preceding claims,~~ claim 1, characterized in that each of said portions (1, 2) of said circulation element is connected to said source (16, 16') of substitution solution.

5.(Amended) Tubing according to ~~one of the preceding claims,~~claim 1, characterized in that said conduit (29) for connecting at least one of said portions of said circulation conduit (1, 2) to said source of substitution solution, comprises a junction and switching means (32) alternatively to connect said portion to at least two chambers (16, 16') for said solution.

6.(Amended) The use of tubing according to ~~one of the preceding claims,~~claim 1, said circulation conduit (1, 2) forming a closed loop, characterized in that the liquid is caused to circulate in said closed circulation loop (1, 2) to evacuate air which it contains, through said connection conduit (8).

7.(Amended) The use of the ~~preceding~~ tubing according to claim 6 characterized in that the extraction pump for blood is actuated when the blood return pump (17) is stopped and until the pressure measured by the detector (42) reaches or exceeds a predetermined threshold value.

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TUBING FOR THE EXTRACORPORAL PURIFICATION  
OF THE BLOOD AND USE OF THIS TUBING

5 The present invention relates to tubing for the  
extracorporal purification of the blood of a human being or of  
a warm-blooded animal, comprising an open loop extracorporal  
circulation conduit having two portions, one for extraction of  
the blood to be purified, the other for returning the purified  
blood, adapted to be connected to purification means, at least  
10 one conduit for connecting at least one of said portions to a  
source of a substitution solution, a bubble trap located along  
said loop, an evacuation conduit for the product rejected by  
said purification means, provided with a segment shaped to  
serve as a pump body adapted to be connected with a  
15 parastaltic pump and connection means to connect one to the  
other, removably, the respective ends of said open loop  
extracorporal circulation tubing to form a closed loop. This  
invention also relates to the use of this tubing.

20 This type of tubing is used particularly for persons  
suffering from renal insufficiency, requiring eliminating one  
or several harmful substances and/or to control their weight  
over time. The devices which exist for treating patients with  
renal failure are generally designed to be used by  
professionals in a hospital setting. In the case of chronic  
25 failure, the sick person must regularly attend, typically

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three times per week, a specialized hospital setting, to the detriment of his quality of life.

In the case of acute failure associated with a crisis condition and limited in time, a sick person is treated in intensive care by a non-specialized person administering this type of therapy.

The principal methods of treatment are hemodialysis, which consists in ion exchange by diffusion, between the blood and a so-called dialyzate liquid, and hemofiltration which acts by convection by mechanically filtering the blood. The two methods use an artificial membrane as a semi-permeable filter.

This treatment process comprises three phases, comprising a phase of preparing the tubing, a treatment phase properly so-called, and a process of storing the tubing. The preparation comprises two sequences which are often separate, starting the circuit which permits filling the tubing and the filter by eliminating air, and rinsing which cleans the tubing and the filter so as to carry out the treatment. After this treatment, according to whether or not it is desired to reuse the tubing, it is disinfected by leaving in the interior a disinfectant which avoids the development of bacteria, or it is emptied before discarding it.

To prepare a tubing of the state of the art so as to carry out an extracorporeal purification of the blood, the end of the tubing to extract the blood is connected to a reservoir of solution and the end of this tubing for returning the blood is connected to a liquid collector. This solution is then circulated by means of the pump for extracting the blood, from the solution reservoir to the liquid collector.

This process of preparation involves several drawbacks. It requires the use of supplemental sacks which must then be eliminated while observing safety precautions. At each change, the sacks must be opened and closed. It thus involves substantial work of manipulation. Moreover, the tubing is not reusable, because of the complexity of the emptying and cleaning operations that this reuse would require.

The phases of preparation and of storage of the device are thus complicated to carry out and require a great deal of time. During treatment, the purge of the tubing and its changing of the liquid reservoir also require time and are moreover difficult to carry out by the patient himself.

There has already been proposed, particularly in U.S. Patent 4,888,004, as well as in WO 90/15631, tubing comprising removable connection means between the two ends of the open loop to form a closed loop, permitting circulating a rinsing solution or to start the circuit before treatment of a

patient. Although these publications relate to circuits comprising particularly a bubble trap, adapted to separate the gaseous phase from the liquid phase, none of them permits establishing a direct communication between the bubble trap and the recovery reservoir. Thus, in WO 90/15631, the conduit connecting the bubble trap to the recovery reservoir is in connection with a peristaltic pump, such that the gaseous phase cannot be freely evacuated. Eventually, it overfills, because the flow through the evacuation conduit is controlled by the peristaltic pump. In U.S. 4,888,004, no conduit connects the bubble trap to the recovery reservoir.

The object of the present invention is to overcome at least in part the above-mentioned drawbacks.

To this end, this invention first of all has for its object tubing of the type mentioned above, according to claim 1.

This invention also has for its object a use of the tubing, as defined by claim 6.

The tubing according to this invention is particularly simple to use such that it renders treatment accessible to the sick person who can care for himself at home, or in a specialized center, in the measure to which it permits reducing to the minimum any intervention in the course of the three phases of the treatment process. It thus has been

designed for automatic control, or semi-automatic control of all its operating phases both before, during and after the blood purification treatment. It also thus permits being used in a hospital setting by personnel who are not specialized in this type of treatment, particularly by intensive care personnel.

Thanks to its design, this tubing can not only serve freely to evacuate the gas, but also the liquid overflow, whilst permitting detecting the undesirable presence of blood which might flow accidentally through the evacuation conduit. These advantages result in greater safety for the patient, a decrease of the risks of infection, and simplicity of use.

The accompanying drawings show, very schematically and by way of example, one embodiment of the tubing, as well as a manner of use of this tubing, according to the present invention.

Figure 1 shows the diagram of a device for hemofiltration or plasmapheresis, in which is used tubing according to this embodiment;

Figure 2 shows a procedure for preparation of the tubing for a purification process;

Figure 3 shows a procedure for storing this tubing;

Figures 4a-4c show in detail on a larger scale connection means seen respectively in side elevation (4a), turned 90°

about a transverse axis (4b) and in side elevation assembled to the ends of the tubing (4c);

Figure 5 shows a modification of the tubing permitting connecting the intracorporal circulation system of the patient to the extracorporal circulation conduit by means of a single vascular access.

The tubing of the present invention comprises an open loop conduit which comprises an extracting tubing 1 separated from a return tubing 2 by a filter 6 or any other suitable purification means. In the return tubing 2 are disposed an air bubble detector 3 and a clamp 4. A peristaltic pump 5 serves principally to extract the blood from the patient and to cause it to circulate in the open loop when the two ends are connected to two separate portions of the intracorporal blood circulation of the patient. A bubble trap 7 permits on the one hand stopping air bubbles moving in the extracorporal circulation loop and on the other hand introducing and/or withdrawing fluids in this circulation loop 1, 2.

This tubing also comprises a filtered liquid extraction conduit 28, associated with an extraction pump for the rejected product 19, a blood loss detector 14 and a collector 15 for this rejected product. A pressure detector 25, an electrical conductivity detector 26, a temperature detector 27 and an acid-basic equilibrium detector 24, will also

preferably be associated with this extraction conduit 28. These detectors could also be associated with display means (not shown) and with computation means (not shown) used for control of the purification process.

5       The tubing according to the invention also comprises a conduit 29, permitting connecting a source of substitution solution 16 to the extracorporeal circulation loop 1, 2. This conduit 29 is associated with a circulation pump 17 controlling the flow rate of the substitution solution in a  
10       conduit 30 which connects the conduit 29 to the return tubing 2 of the extracorporeal circulation loop. A second conduit 31 connects the conduit 29 to the extraction tubing 1 of the extracorporeal circulation open loop. Preferably, this second conduit 31 is in two portions assembled by a connector 44  
15       whose role is explained in the description of the cleaning procedure. A pump 18 associated with this conduit 31 controls the flow rate of the substitution solution which flows toward the extraction tubing 1. As a modification, there could be used a single pump associated with the conduit 29 and a flow  
20       rate distributor disposed in the branching of the conduits 30 and 31.

      The connection conduit 8 connects the circulation loop 1, 2 to the extraction tubing 28. This connection conduit 8 leaves the bubble trap 7 and leads to the blood detector 14.

Thanks to this connection conduit 8, the circulation loop is sealed to the ambient air whilst permitting evacuating the bubbles which it encloses, generally in the form of a mixture of the liquid and gaseous phases. This conduit preferably is an integral part of the tubing and can thus be sterilized with it. To permit the air to escape toward the atmosphere, the collector 15 can be provided with an overpressure valve 48, or the collector could be in an unsealed location. A sealed and flexible pocket empty at the beginning of the treatment is also a possible embodiment of the collector 15.

A non-return valve 49, disposed along the connection conduit 8, permits flow of liquid in this conduit only in the direction from the circulation loop 1, 2 toward the evacuation conduit 28 and thus prevents the rejected product from reaching the bubble trap 7 in case of a handling error. A clamp 47 permits controlling the flow rate in this connection conduit 8, and permits closing this connection.

This connection conduit 8 avoids the entry of air into the circulation loop 1, 2 in case of error of handling, because it is immersed in the blood detector 14 which is normally filled with ultrafiltrate. If this detector detects the presence of blood, it emits a signal adapted to stop the pumps 5, 17, 18 and 19. Moreover, this connection conduit 8 avoids any loss of liquid to the outside.

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In the modification shown in Figure 5, a sealed buffer reservoir 50 is added in the section of the circulation loop between the pumps 5 and 17, this latter being disposed in the return tubing 2, a Y shaped connection 52 connects the extraction tubing 1 to the return tubing 2, and the extracorporeal circulation loop thus formed with a single access to the blood circulation of the patient, the connection 11 becoming a plug whose shape can permit or not the circulation of the liquid outside the connection 51. The connection between the source of solution 16 and the extracorporeal circulation loop is disposed in the extraction tubing 1, it could also be disposed in the return tubing 2 or in both.

Preferably, the recovery chamber 15 and one or several substitution solution sources 16, 16' are constituted by flexible pockets disposed in one or several containers 12, preferably rigid. The information as to this container 12 can preferably be recorded and displayed by a member 23. The container used and the different possible embodiments correspond preferably to the container described in FR 2782916, to which reference can be had for more details.

A weighing device 10 can be associated with the container 12 to measure the quantities of exchanged liquid. As modifications, these weighing means can be replaced by means

for measuring the volume or the liquid level or else by detectors of flow rate which give equivalent information.

Different detectors can complete the device, particularly detectors of movement of the pumps (not shown), pressure  
5 detectors (40, 41, 42, 25), or else one or several temperature detectors 27.

The different detectors associated with the tubing of the invention are connected to computing means (not shown) which  
comprise essentially electronic and computer means permitting  
10 particularly gathering and processing information to act on different members.

There can also be provided a heating means 43 for the blood and/or for the substitution solution and/or for disinfection, which heating means can be disposed at any place  
15 in the device.

After emplacement of the tubing on the apparatus according to Figure 1, starting use of the tubing consists first, if it has not already been done, in connecting one to the other the two ends of the open loop with the help of the  
20 connection conduit 11. This connection conduit 11, shown in greater detail in Figures 4a, 4b, 4c, has two connections 11a, 11b which are identical to those which permit connecting the tubing to the blood circulation of the patient by means of a catheter or another connection element (not shown), such that

the open ends 45, 46 of the tubing 1, 2 can thus be adapted as desired to catheters or to the connection conduit 11. The internal volume of this connection conduit 11 is almost nothing, to avoid losses of liquid during connection of this tubing to the patient, to which are secured the ends 45, 46. Preferably, the connection conduit 11 is thus designed such that the two ends of the open circulation loop 1, 2 will be placed end to end. Preferably, this connection conduit 11 is of a plastic material and is sterilized at the same time as the rest of the tubing with which it is sold. An enlarged portion 11c can be provided to facilitate the handling of the connection during operations of connection and disconnection.

According to a preferred preparation procedure shown in Figure 2, startup consists in causing to turn the blood extraction pumps 5, pre-dilution and post-dilution pumps 17, 18, so as to fill the tubing 1, 2 and the associated filter 6, the extraction pump 19 for the rejected product is also actuated to assist in purging the circulation loop 1, 2, but at a lower flow rate. During the rinsing phase, the extraction flow rate of the filtrate from the pump 19 is maintained at a lower value, if desired zero, than the sum of the pre-dilution and post-dilution flow rates of the pumps 17 and 18, the extraction pump 5 of the blood providing a flow rate sufficient so as to not lessen that of the pumps 17 and

18. The tubing is thus filled with liquid during all the operation, the overflow, evacuated through the conduit 8, having a flow rate equivalent to the difference between that withdrawn (filtrate) and that added (pre-dilution and post-dilution).

Stopping these two starting operations and rinsing, takes place ordinarily automatically when the masses of substitution solution previously determined have been exchanged. Emergency stopping can be carried out by the user himself or by an alarm, for example when air bubbles are detected by the detector 3 during rinsing.

At the end of rinsing, an operation consisting in activating the blood pump 5 and the filtrate pump 19 simultaneously, permits reducing the level of liquid in the bubble trap 7. The clamp 47 is then closed to carry out purification of the blood.

In the case of the tubing shown in Figure 5, starting and rinsing follow the same principle as previously described. The pump 18 injects the liquid at a flow rate greater than the extraction flow rate provided by the pump 19, the surplus being eliminated through the conduit 8, the pumps 5 and 17 disposed in the extracorporeal circulation conduit being controlled so as to maintain a reasonable pressure in all of the circuit, thereby avoiding harming this latter. This

control is based preferably on the indications of the pressure detectors 40, 41, 42, 25.

5 A supplemental advantage of the closing of the circulation loop 1, 2 by the connection conduit 11 is to make possible the control of the pressure detectors during rinsing. The closing of this circulation loop 1, 2 by undeformable elements, permits verifying that the pressures read by the detectors 40 and 41 are identical and that the increase when the pump 18 and/or the pump 17 turn, whilst the others are  
10 stopped. It can be verified that the pressure read by the detector 25 increases proportionally to the flow rate of the extraction pump 19 for the filtrate, for a flow rate that is constant and not zero, of the blood extraction pump 5. It can thus be verified that the pressure read by the detector 42  
15 increases proportionally to the flow rate of the pump 5, the others being stopped.

Pressure variations measured as a function of the movement of these pumps, are compared to a reference curve recorded in a memory during a calibration procedure for the  
20 apparatus. The comparison of the measurements with the corresponding reference curve permits determining whether the response of the pressure detectors is correct, by applying conventional single processing methods. It should be noted that one also verifies here, that the pumps are occlusive and

that the tubing used is that which corresponds to the process which is to be carried out, these conditions being necessary to obtain a satisfactory response for the pressure detectors.

To purge air from the circulation loop 1, 2, in the course of the blood purification phase, the clamp 47 is open, which is normally closed during this purification phase. This opening can be controlled automatically or manually. The clamp 4 is closed to prevent bubbles from reaching the patient, then a procedure is automatically begun which causes the pump 17 to turn, the surplus of injected liquid replacing progressively the air bubbles which are eliminated through the connection conduit 8. The operator stops the process when he detects that the liquid level in the bubble trap 7 is sufficient to carry out purification of the blood. The connection conduit 8 is then closed and the clamp 4 is again opened to let the blood circulate.

If the circulation of the blood by means of the tubing is evident in the conventional case shown in Figure 1, it should be pointed out how it is ensured in the case of single access to the blood circulation of the patient. During rinsing, the buffer reservoir 50 is filled with liquid. At the beginning of a blood purification phase, the device begins to return this liquid to the patient by activating the pump 17, the others being stopped. After a certain volume of liquid or a

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certain time has passed, the pump 17 is stopped and the pumps 5, 18 and 19 are actuated, thereby compressing the air present between the blood contained in the reservoir 50 and the top of this latter, until a pressure measured by the detector 42 is greater than a known limit of the system. Purification is thus carried out by ensuring a sufficient filling level, to ensure the continuity of blood circulation, from the reservoir 50 at each cycle. This cycle in two phases is repeated until the end of the purification session.

10       The condition of a successful operation is that the volume of liquid withdrawn during each cycle from the reservoir 50 by the pump 17 will be less than the volume of the reservoir itself.

15       A large problem of extracorporeal purification treatments is the financial and ecological cost of the consumable elements associated with each treatment.

      The use of the tubing according to the invention permits saving on apparatus and carrying out the storage phase which will be described with respect to Figure 3.

20       First the end 45 of the blood extraction portion 1 is disconnected from the tubing of the catheter, the pre-dilution conduit 31 is separated at the connector 44 and the end 45 is connected to the pre-dilution conduit portion 31 which communicates with the source 16 or 16' of solution. The

solution is then pumped with the pump 5 so as to return the blood to the patient.

Once this operation is completed, the ends 45 and 46 of the circulation loop are disconnected to reconnect them with the connection conduit 11 positioned as during startup of the tubing. The two portions of the pre-dilution conduit 31 are again connected to the connection 44. The clamp 47 is opened, which closes the connection conduit 48, then complete emptying or disinfection of the tubing is carried out. Disinfection can be followed by rinsing with another solution or an emptying. As a modification, if it is desired to carry out only emptying, the end 46 can be disconnected from the patient and placed such that its content is voided, via an opening (not shown), directly into the container 15, thereby avoiding having to touch other portions of the tubing.

Emptying the circuit is carried out by causing all the pumps to turn, preferably with the clamps open, all of the liquid returning thus to the collector 15 and being measured by the balance 10. Emptying is stopped when the weight measured by the balance indicates that the flow rates relating to it are zero. Disinfection is carried out by orienting a valve 32 toward a compartment, for example 16', which can contain a disinfection liquid, for example acid or a concentrated saline solution, which is caused to circulate by

the pumps under conditions identical to those for rinsing the circulation loop 1, 2, so as to ensure that all of this loop is placed in contact with the disinfectant. This step is completed after a certain time has passed or a certain volume has flowed. To carry out rinsing after disinfection, the valve 32 is oriented toward the compartment 16, which contains the rinsing solution, then the pumps are actuated under the same conditions as above. Rinsing is completed according to the same criteria as disinfection.

10 Different precautions can be taken to carry out the operations and to ensure that the fluid used for disinfection is correctly rinsed before beginning the purification operation. The control is carried out preferably, on the one hand, at the level of the valve 32, whose movement is  
15 controlled by means of at least one detector (not shown), and on the other hand, thanks to an acid-basic equilibrium detector 24 and/or a detector of electrical conductivity 26 disposed in the extraction tubing 28. The measurement is carried out when the extraction pump 19 is actuated, the value  
20 obtained being then representative of that of the liquid circulating in the circulation loop 1, 2. This measured value can then be compared with a memorized reference value.

## CLAIMS

1. Tubing for the extracorporeal purification of the blood of a human being or a warm-blooded animal, comprising an open loop extracorporeal circulation conduit having two portions, one for extraction of the blood to be purified (1),  
5 the other for return of the purified blood (2), adapted to be connected to purification means (6), at least one conduit (29, 30, 31) to connect at least one of said portions (1, 2) to a source (16, 16') of a substitution solution, a bubble trap (7) located along said loop, an evacuation product (28) for  
10 product rejected into a recovery chamber (15) by said purification means, provided with a segment adapted to serve as a pump body adapted to be connected with a peristaltic pump and connection means (11) removably to connect to each other the respective ends (45, 46) of said open loop extracorporeal  
15 circulation tubing (1, 2) to form a closed loop, said evacuation conduit (28) for rejecting product comprising, downstream of said segment adapted to serve as a pump body, a blood detector (14), characterized in that a connection conduit (8) extends between the downstream end of said segment  
20 adapted to serve as a pump body and said bubble trap (7).

2. Tubing according to claim 1, characterized in that it moreover comprises a buffer reservoir (50) in the section of the circulation loop adapted to be located downstream of said purification means.

5

3. Tubing according to one of the preceding claims. characterized in that said connection conduit (8) comprises means (47) to control the flow rate through it.

4. Tubing according to one of the preceding claims characterized in that each of said portions (1, 2) of said circulation element is connected to said source (16, 16') of substitution solution.

5

5. Tubing according to one of the preceding claims, characterized in that said conduit (29) for connecting at least one of said portions of said circulation conduit (1, 2) to said source of substitution solution, comprises a junction and switching means (32) alternatively to connect said portion to at least two chambers (16, 16') for said solution.

6. The use of tubing according to one of the preceding claims, said circulation conduit (1, 2) forming a closed loop, characterized in that the liquid is caused to circulate in

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said closed circulation loop (1, 2) to evacuate air which it  
5 contains, through said connection conduit (8).

7. The use of the tubing according to claim 6  
characterized in that the extraction pump for blood is  
actuated when the blood return pump (17) is stopped and until  
the pressure measured by the detector (42) reaches or exceeds  
5 a predetermined threshold value.

8. The use of the tubing according to claim 7,  
characterized in that when the process of purification of the  
blood is completed, the inlet end of said circulation conduit  
is connected to a source of substitution liquid and this  
5 liquid is caused to circulate to push back the blood contained  
in this circulation conduit (1, 2) through the other end of  
this open loop.

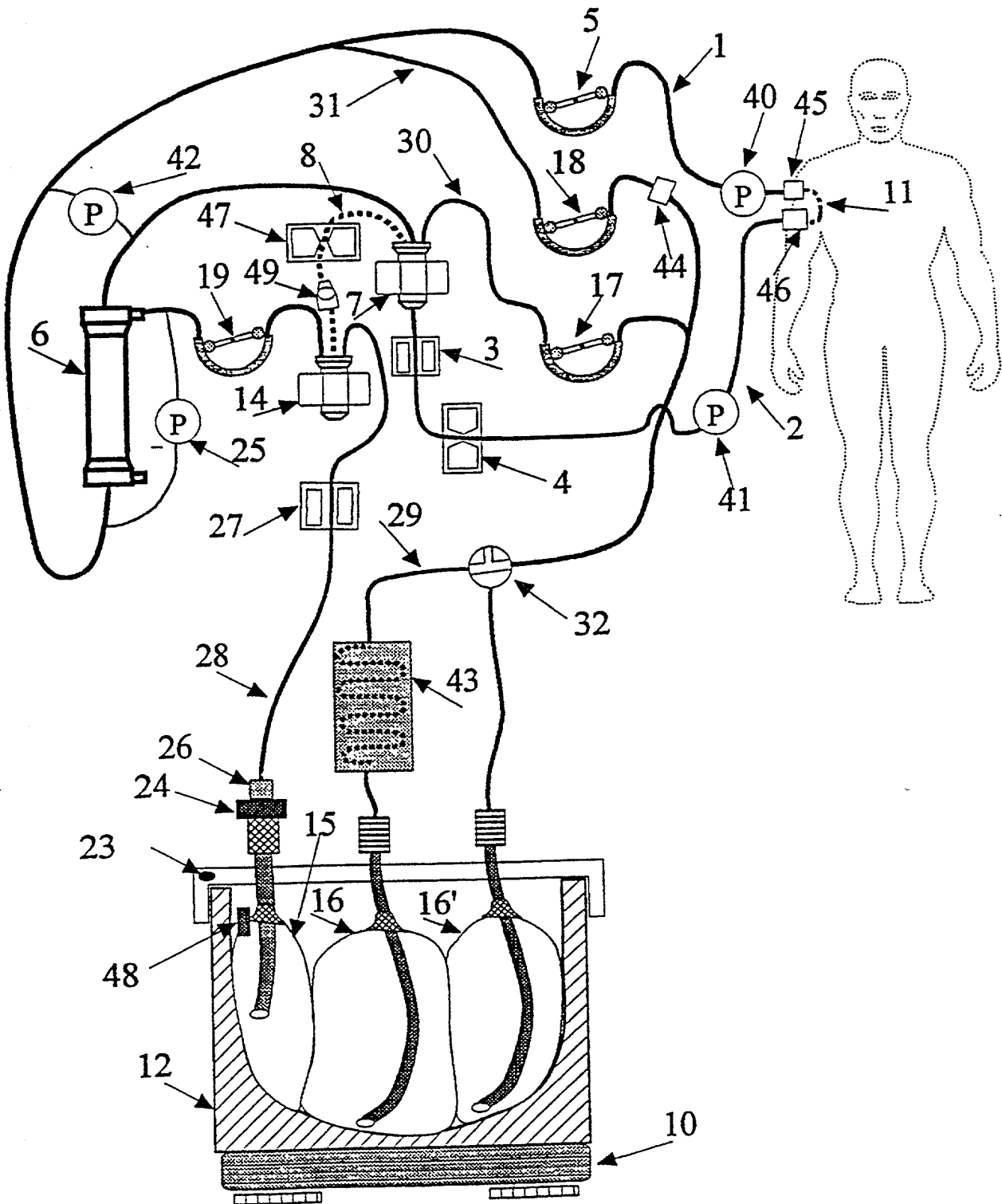
9. The use of the tubing according to claim 7,  
characterized in that the inlet end (45) and outlet end (46)  
being directly connected to each other, this closed loop is  
filled during a preparation or storage phase, by supplying  
5 with a substitution or disinfecting fluid until a  
predetermined mass of said solution has circulated through  
said closed loop.

10. The use of the tubing according to claim 7, characterized in that the pumps (5, 17, 18, 19) are controlled until the tubing and the solution pocket (16, 16') contain no more liquid.

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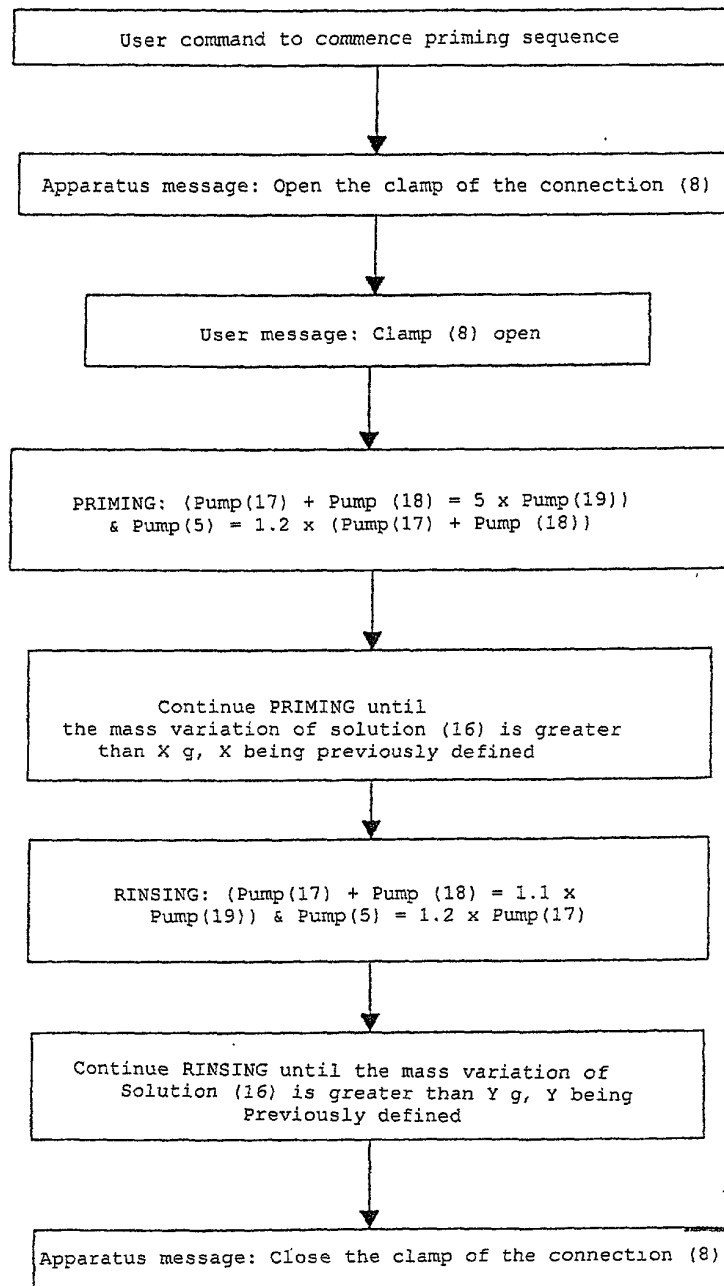
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**Figure 1**

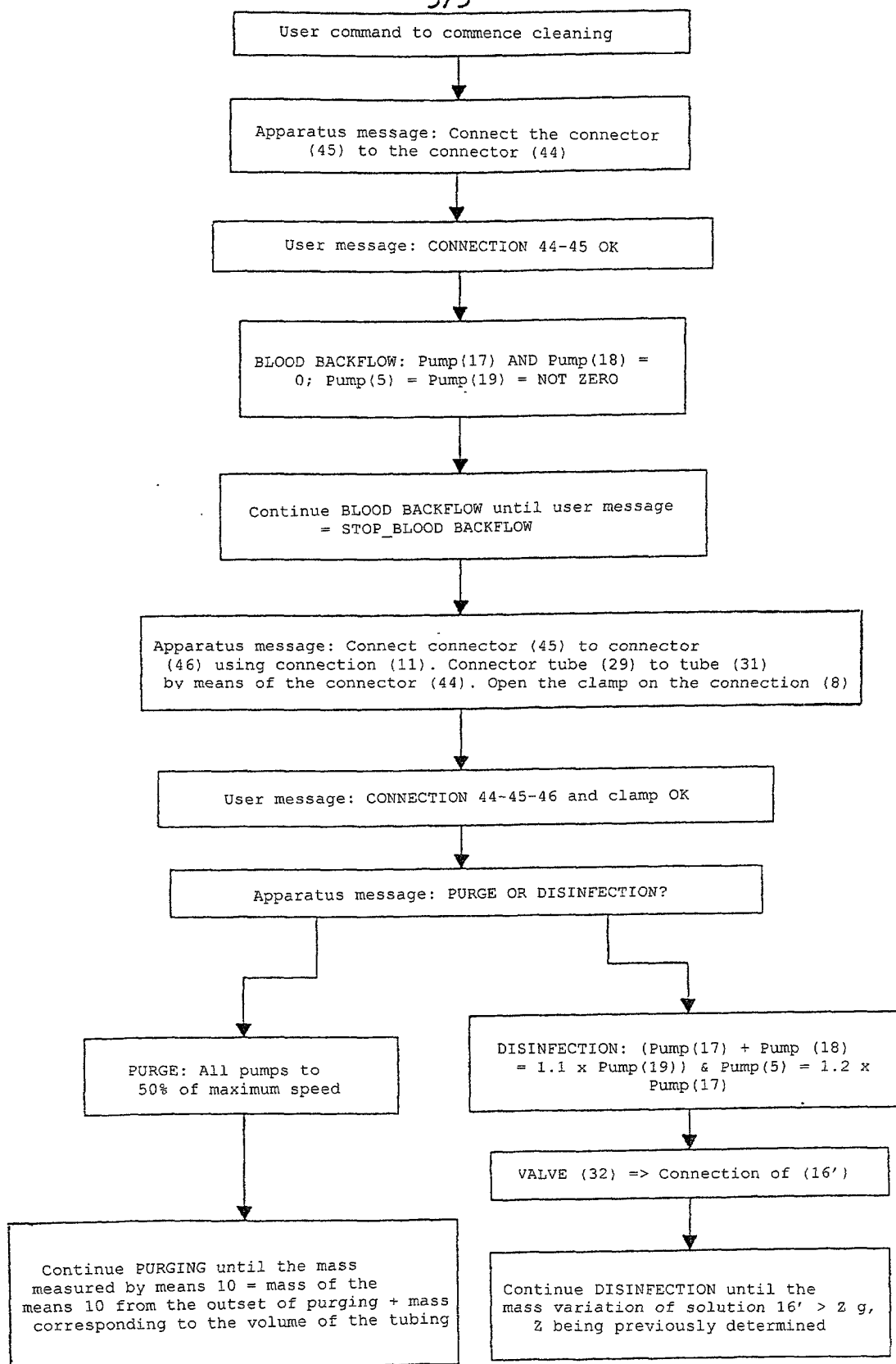
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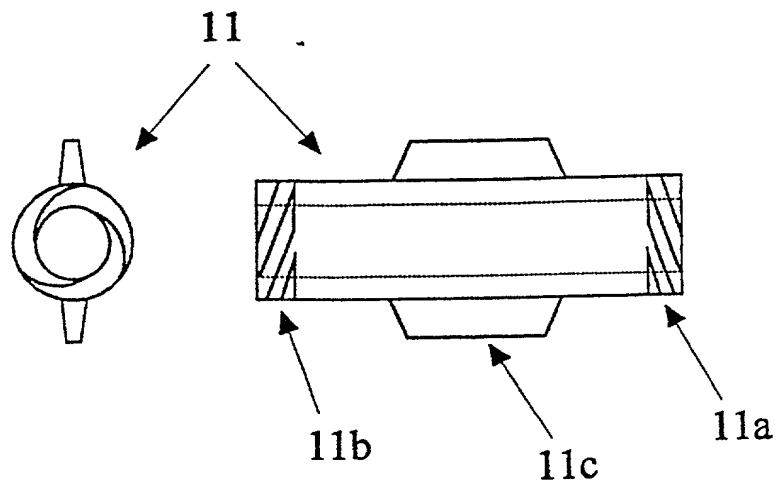
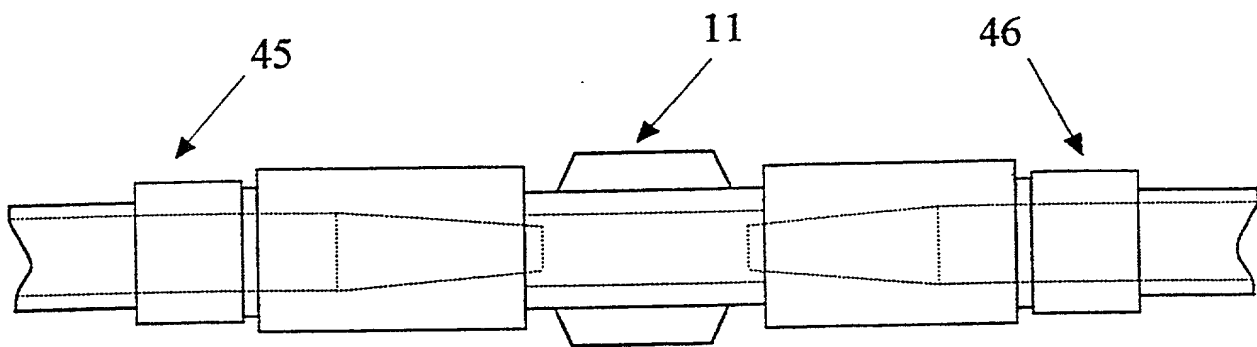
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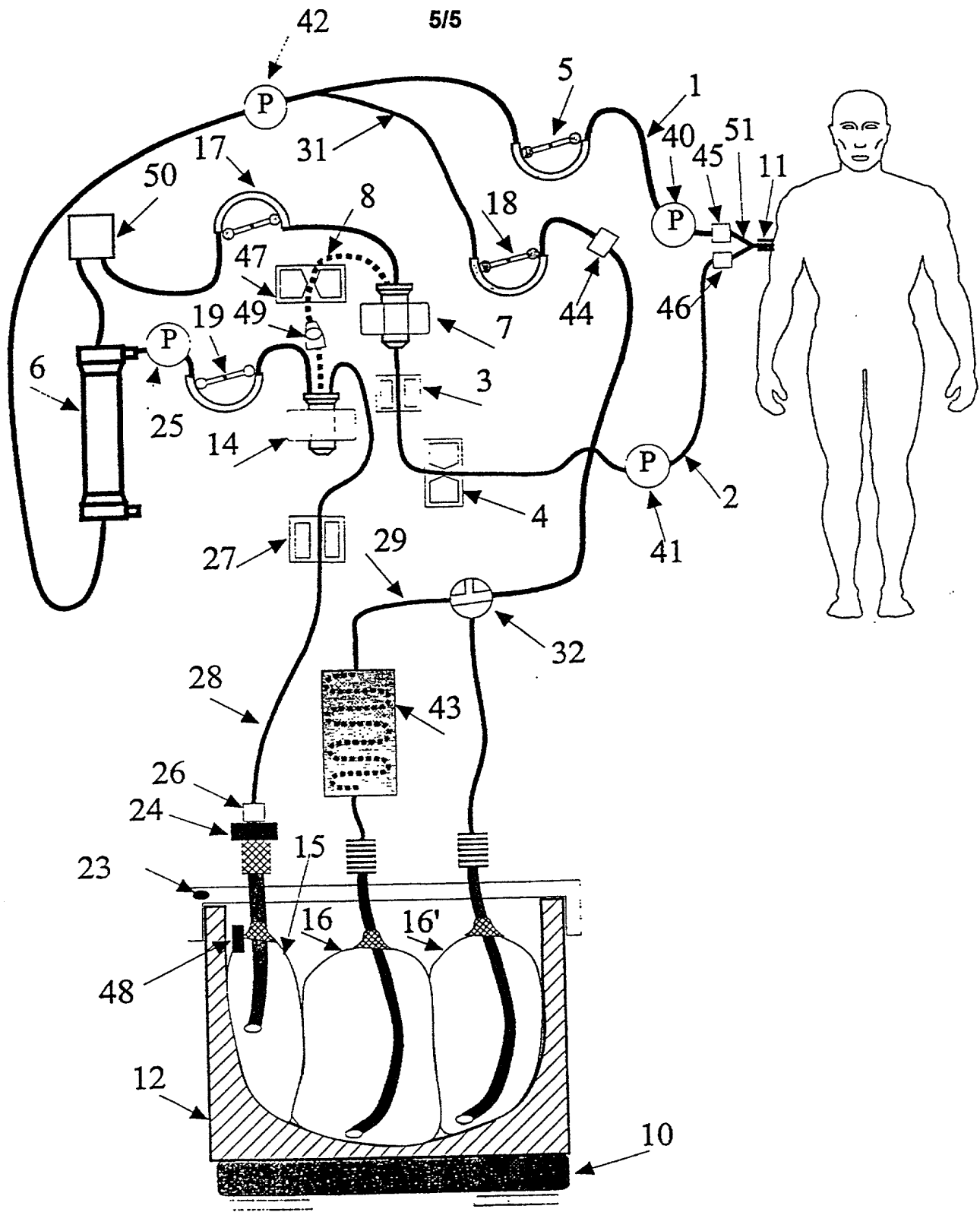
**Figure 2**

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**Figure 3**

**Figure 4a****Figure 4b****Figure 4c**



**Figure 5**

# COMBINED DECLARATION AND POWER OF ATTORNEY

As a below named inventor, I hereby declare that

My residence, post office address and citizenship are as stated below next to my name.

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled:

the specification of which: *(check one)*

## REGULAR OR DESIGN APPLICATION

- ☐ is attached hereto.
- ☐ was filed on as application Serial No. and was amended on (if applicable).

## PCT FILED APPLICATION ENTERING NATIONAL STAGE

- ☒ was described and claimed in International application No. filed on and as amended on (if any). Nr PCT/IB00/00216 filed on February 28, 2000

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose information which is material to patentability as defined in Title 37, Code of Federal Regulations, §1.56.

## PRIORITY CLAIM

I hereby claim foreign priority benefits under 35 USC 119 of any foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application for patent or inventor's certificate having a filing date before that of the application on which priority is claimed.

## PRIOR FOREIGN APPLICATION(S)

Country	Application Number	Date of Filing (day, month, year)	Priority Claimed
FRANCE	99/02732	2 March 1999	YES

*(Complete this part only if this is a continuing application.)*

I hereby claim the benefit under 35 USC 120 of any United States application(s) listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of 35 USC 112, I acknowledge the duty to disclose information which is material to patentability as defined in Title 37 Code of Federal Regulations §1.56 which became available between the filing date of the prior application and the national or PCT international filing date of this application:

(Application Serial No.)

(Filing Date)

(Status--patented, pending, abandoned)

POWER OF ATTORNEY

The undersigned hereby authorizes the U.S. attorney or agent named herein to accept and follow instructions from as to any action to be taken in the Patent and Trademark Office regarding this application without direct communication between the U.S. attorney or agent and the undersigned. In the event of a change in the persons from whom instructions may be taken, the U.S. attorney or agent named herein will be so notified by the undersigned.

As a named inventor, I hereby appoint the registered patent attorneys represented by Customer No. **000466** to prosecute this application and transact all business in the Patent and Trademark Office connected therewith, including: **Robert J. PATCH, Reg. No. 17,355, Andrew J. PATCH, Reg. No. 32,925, Robert F. HARGEST, Reg. No. 25,590, Benoît CASTEL, Reg. No. 35,041, Eric JENSEN, Reg. No. 37,855, Thomas W. PERKINS, Reg. No. 33,027, and Roland E. LONG, Jr., Reg. No. 41,949,**

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I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

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Full name of third joint inventor, if any:  
(given name, family name)

Inventor's signature \_\_\_\_\_

Date \_\_\_\_\_

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Citizenship:

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